PRELAB: MEASUREMENT / DENSITY

This line is the “0” for the Vernier scale. Use its position to read the last value before the decimal point.

It often sits between two values on the main scale. Record the smaller value.

We now use the rest of the Vernier scale to determine the decimal places.

A green ruler with numbers and a black handle

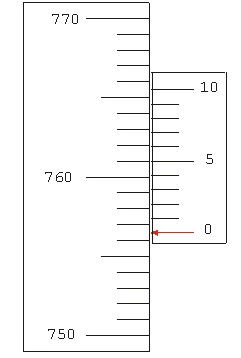
Description automatically generated

Find the first value on the Vernier scale which matches perfectly with the main scale. Use that value.

A ruler and a piece of metal

Description automatically generated

There are two criteria for your recorded measurements of length, width and height. The unit must have two decimal places and be recorded in the unit of centimeters. Our Vernier calipers measure in millimeters, so to get to centimeters you must divide each reading by 10.



Read the scale and select the scale value, before the “0” of the Vernier …..

So, notice where the “0” on the Vernier is in the example to the left … It is between

The ***scale values*** of 756 and 757.

Select the lower value of 756.

Now, scan the Vernier system to find out where there is a match between the Vernier and the Scale. … Notice at the Vernier of 5, it matches perfectly with the Scale.

Hence, the measurement is 756.5 mm.

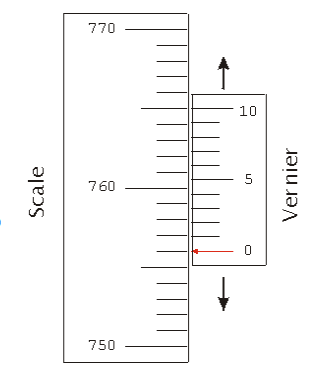
Divide this value by 10 to convert to centimeters.

This gives you 75.65 cm, which has 2 decimal places.

SCALE

VERNIER

<https://faraday.physics.utoronto.ca/PVB/Harrison/Vernier/Vernier.html>

**What if the Vernier, at 0 matches perfectly with the scale?**

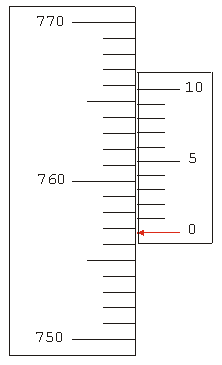
Notice that the “0” of the Vernier matches up precisely with the value of 756 on the scale.

Hence, this reading should be recorded as 756 mm.

Divide this value by 10, and you get 7.56 cm. This answer is what you should record. It meets the 2 criteria of your lab manual directions …. It has 2 decimal places and is in the unit of centimeters.

<https://faraday.physics.utoronto.ca/PVB/Harrison/Vernier/Vernier.html>

**What if no Vernier measurement matches perfectly with the scale?**



Read the scale and select the scale value, before the “0” of the Vernier …..

So, notice where the “0” on the Vernier is in the example to the left … It is between

The ***scale values*** of 756 and 757.

Select the lower value of 756.

Now, scan the Vernier system to find out where there is a match between the Vernier and the Scale. … Notice that the Vernier values of 7 and 8 are close. Here you may estimate by taking the smaller value (7) and breaking the space between 7 and 8 into 10 units.

Hence, the measurement is 756.71 mm.

Divide this value by 10 to convert to centimeters.

This gives you 75.671 cm, which may be rounded to 75.67 cm … meeting the 2 criteria of the lab.

SCALE

VERNIER

<https://faraday.physics.utoronto.ca/PVB/Harrison/Vernier/Vernier.html>

**Reading a Graduated Cylinder**:

A measuring cup with numbers and a number

Description automatically generated with medium confidenceWhenever making a measurement with a graduated cylinder, the recorded value must be read to the smallest marked division and then have an estimated value.

So, study the following diagram representing part of a graduated cylinder:

19

18

17

16

15

14

13

12

11

Notice that the smallest marked division is in 1 mL intervals.

I've tried to show you this, by writing in the values, between

10 and 20 ...trying to match the numbers up with the markings.

Since you can read the meniscus of the fluid to 1 mL, you should

then estimate one more value, and instead of recording a whole

number (such as 16 or 17) ... you should record to a tenth or 0.1 ml

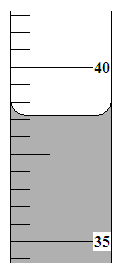
A good answer would be 16.7 mL. Someone else may record 16.8 mL or 16.9 mL. Okay!

You see, the **point to estimating one more value, beyond the marking is to better approximate**

**the reality of the volume. Recording 16.8 mL may be imperfect ... but it is far better than**

**recording 17 mL or worse yet, 16 mL.**

Look at this diagram: You'll notice that there are 10 divisions between 50 and 51 ... this means



**50**

**51**

each marked line represents a 0.1 mL. Thus, since you can read with

accuracy to 0.1 mL ... you should record the volume to 0.01 mL.

Hence, recording 50.7 mL is **inappropriate**.

**A far better reading** is 50.70 mL or 50.71 mL ... Such a reading lets

someone know that you used a graduated cylinder that had markings to

0.1 mL, because the reading is written to a hundredth of a mL (0.01 mL)

**TRY THIS!** Complete each of the following practice problems. Recall that the focus of this section is to practice recording measurements with the correct number of decimal places. Study the diagram. Then analyze

the division and check it off (🗸). Once you know the smallest marked division, you know to what extent you

need to actually read the cylinder's volume.

A measuring cup with a white background

Description automatically generated with medium confidence

|  |  |  |
| --- | --- | --- |
| **Division Analysis**  The smallest marked  division is in | **Reading between**  **the lines**  So, this can be read to the | **Answer**  **(mL)** |
| **🗸**1 mL  0.1 mL | **🗸**0.1 (tenth …1 decimal place)  or  0.01 (hundredth…2 decimal places) | **34.3** |

E.g.)

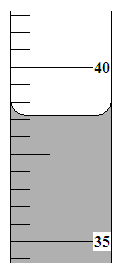
\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

A measuring cup with numbers and a number

Description automatically generated with medium confidence

|  |  |  |
| --- | --- | --- |
| **Division Analysis**  The smallest marked division is in | **Reading between**  **the lines**  So, this can be read to the | **Answer**  **(mL)** |
| **🗸**1 mL  0.1 mL | 0.1 (tenth …1 decimal place)  or  0.01 (hundredth…2 decimal places) | \_\_\_\_\_\_\_\_\_ |

1)



39

|  |  |  |
| --- | --- | --- |
| **Division Analysis**  The smallest marked division is in | **Reading between**  **the lines**  So, this can be read to the | **Answer**  **(mL)** |
| 1 mL  0.1 mL | 0.1 (tenth …1 decimal place)  or  0.01 (hundredth…2 decimal places) | \_\_\_\_\_\_\_\_\_ |

2)

answers: 1) 16.8 mL your answer can have a ± 0.1 range

2) 39.71 mL your answer can have a ± 0.01 mL range

A grey ruler with white text

Description automatically generated3)

|  |  |  |
| --- | --- | --- |
| **Division Analysis**  The smallest marked division is in | **Reading between**  **the lines**  So, this can be read to the | **Answer**  **(mL)** |
| 1 mL  0.1 mL | 0.1 (tenth …1 decimal place)  or  0.01 (hundredth…2 decimal places) | \_\_\_\_\_\_\_\_\_ |

A grey measuring cup with black lines

Description automatically generated with medium confidence

|  |  |  |
| --- | --- | --- |
| **Division Analysis**  The smallest marked division is in | **Reading between**  **the lines**  So, this can be read to the | **Answer**  **(mL)** |
| 1 mL  0.1 mL | 0.1 (tenth …1 decimal place)  or  0.01 (hundredth…2 decimal places) | \_\_\_\_\_\_\_\_\_ |

4)

A measuring cup with numbers and a ruler

Description automatically generated

|  |  |  |
| --- | --- | --- |
| **Division Analysis**  The smallest marked division is in | **Reading between**  **the lines**  So, this can be read to the | **Answer**  **(mL)** |
| 1 mL  0.1 mL | 0.1 (tenth …1 decimal place)  or  0.01 (hundredth…2 decimal places) | \_\_\_\_\_\_\_\_\_ |

5)

answers: 3) 27.8 mL your answer can have a ± 0.1 range

4) 66.6 mL your answer can have a ± 0.1 range

5) 58.60 mL your answer can have a ± 0.01 range

A measuring tape with numbers

Description automatically generated6)

|  |  |  |
| --- | --- | --- |
| **Division Analysis**  The smallest division is in | **Reading between**  **the lines**  So, this can be read to the | **Answer**  **(mL)** |
| 1 mL  0.1 mL | 0.1 (tenth …1 decimal place)  or  0.01 (hundredth…2 decimal places) | \_\_\_\_\_\_\_\_\_ |

**36**

|  |  |  |
| --- | --- | --- |
| **Division Analysis**  The smallest division is in | **Reading between**  **the lines**  So, this can be read to the | **Answer**  **(mL)** |
| 1 mL  0.1 mL | 0.1 (tenth …1 decimal place)  or  0.01 (hundredth…2 decimal places) | \_\_\_\_\_\_\_\_\_ |

A measuring device with numbers and a ruler

Description automatically generated with medium confidence

7)

**39**

answers: 6) 35.60 mL your answer can have a ± 0.01 range

7) 39.26 mL your answer can have a ± 0.01 range